

CLAIMS

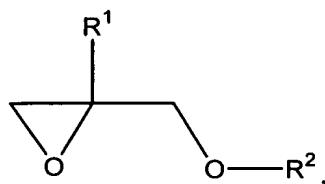
1. A process for preparing a prepolymer mixture for a reactive adhesive comprising
  - (a) mixing in the absence of actinic radiation:
    - (i) a catalyst component comprising from 2 to 50 parts by weight of a cationic photoinitiator chosen from the group consisting of triaryl sulfonium, diaryl iodonium, dialkylphenacylsulfonium and hydroxyphenyl dialkylsulfonium salts having counterions chosen from the group consisting of  $\text{SbF}_6^-$ ,  $[(\text{C}_6\text{F}_5)_4\text{B}]^-$ ,  $\text{AsF}_6^-$ ,  $\text{PF}_6^-$ ,  $\text{C}_4\text{F}_9\text{SO}_3^-$ ,  $\text{FSO}_3^-$ ,  $\text{GaF}_6^-$ ,  $(\text{CF}_3\text{SO}_2)_2\text{CH}^-$ ,  $(\text{CF}_3\text{SO}_2)_3\text{C}^-$ ,  $\text{BF}_4^-$  and  $\text{CF}_3\text{SO}_3^-$ ; with
    - (ii) a monomer/oligomer component comprising 1000 parts by weight of one or more of a monomer or oligomer chosen from oxetane monomers, oxirane monomers, oxetane oligomers and oxirane oligomers, said oxirane monomers and oligomers having at least one oxygen or sulfur of an ether or thioether in a position two or three carbons removed from the oxygen of the oxirane, to provide a pre-irradiation mixture having a first viscosity which is less than 500,000 centipoises; and
  - (b) exposing said pre-irradiation mixture to actinic radiation while maintaining the temperature of said mixture such that spontaneous polymerization is not induced and an activated prepolymer mixture is produced, said activated prepolymer mixture having a viscosity that is functionally unchanged from the viscosity of said pre-irradiation mixture.
2. A process according to claim 1 wherein said step (b) of exposing said mixture to actinic radiation is carried out at or below ambient temperature.
3. A process for preparing and curing a reactive adhesive comprising preparing an activated prepolymer mixture for a reactive adhesive according to claim 1 and
  - (c) applying heat from an external source at a temperature above or at ambient temperature to said activated prepolymer mixture, whereby polymerization is initiated.

4. A process for preparing and curing a reactive adhesive comprising preparing an activated prepolymer mixture for a reactive adhesive according to claim 2 and
  - (c) applying heat from an external source to said activated prepolymer mixture, said external heat source being 10°C or more above the temperature at which said mixture was exposed to actinic radiation.
5. A process for preparing and curing a reactive adhesive comprising:
  - (a) mixing in the absence of actinic radiation:
    - (i) a catalyst component comprising from 2 to 50 parts by weight of a cationic photoinitiator chosen from the group consisting of triaryl sulfonium, diaryl iodonium, dialkylphenacylsulfonium and hydroxyphenyl dialkylsulfonium salts having counterions chosen from the group consisting of  $\text{SbF}_6^-$ ,  $[(\text{C}_6\text{F}_5)_4\text{B}]^-$ ,  $\text{AsF}_6^-$ ,  $\text{PF}_6^-$ ,  $\text{C}_4\text{F}_9\text{SO}_3^-$ ,  $\text{FSO}_3^-$ ,  $\text{GaF}_6^-$ ,  $(\text{CF}_3\text{SO}_2)_2\text{CH}^-$ ,  $(\text{CF}_3\text{SO}_2)_3\text{C}^-$ ,  $\text{BF}_4^-$  and  $\text{CF}_3\text{SO}_3^-$ ;  
with
    - (ii) a monomer/oligomer component comprising 1000 parts by weight of one or more of a monomer or oligomer chosen from oxetane monomers, oxirane monomers, oxetane oligomers and oxirane oligomers, said oxirane monomers and oligomers having at least one oxygen or sulfur of an ether or thioether in a position two carbons removed from the oxygen of the oxirane, to provide a pre-irradiation mixture having a first viscosity which is less than 500,000 centipoises;
  - (b) exposing said pre-irradiation mixture to actinic radiation while maintaining the temperature of said mixture at a first temperature such that spontaneous polymerization is not induced and an activated prepolymer mixture is produced, said activated prepolymer mixture having a viscosity that is functionally unchanged from the viscosity of said pre-irradiation mixture;
  - (c) manipulating said activated prepolymer mixture; and
  - (d) applying heat from an external source at a second temperature to said activated prepolymer mixture, whereby polymerization is initiated, said second temperature being higher than said first temperature.
6. A process according to claim 5 wherein said exposing step (b) comprises exposing said mixture to total irradiation of 500 to 10,000  $\text{mJ/cm}^2$ .

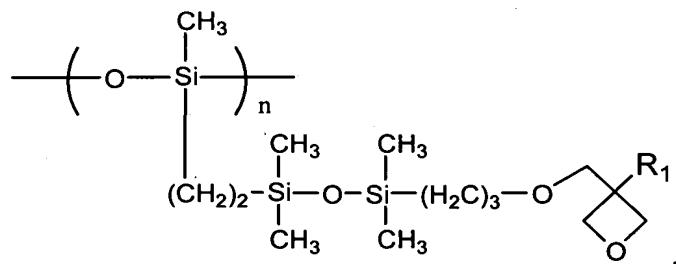
7. A process according to claim 5 wherein said second temperature is 10°C or more above said first temperature.
8. A process for bonding two substrates comprising:
  - (a) a mixing step comprising mixing in the absence of actinic radiation:
    - (i) a catalyst component comprising from 2 to 50 parts by weight of a cationic photoinitiator chosen from the group consisting of triaryl sulfonium, diaryl iodonium, dialkylphenacylsulfonium and hydroxyphenyl dialkylsulfonium salts having counterions chosen from the group consisting of  $\text{SbF}_6^-$ ,  $[(\text{C}_6\text{F}_5)_4\text{B}]^-$ ,  $\text{AsF}_6^-$ ,  $\text{PF}_6^-$ ,  $\text{C}_4\text{F}_9\text{SO}_3^-$ ,  $\text{FSO}_3^-$ ,  $\text{GaF}_6^-$ ,  $(\text{CF}_3\text{SO}_2)_2\text{CH}^-$ ,  $(\text{CF}_3\text{SO}_2)_3\text{C}^-$ ,  $\text{BF}_4^-$  and  $\text{CF}_3\text{SO}_3^-$ ;  
with
    - (ii) a monomer/oligomer component comprising 1000 parts by weight of one or more of a monomer or oligomer chosen from oxetane monomers, oxirane monomers, oxetane oligomers and oxirane oligomers, said oxirane monomers and oligomers having at least one oxygen or sulfur of an ether or thioether in a position two or three carbons removed from the oxygen of the oxirane,  
to provide a pre-irradiation mixture having a first viscosity which is less than 500,000 centipoises;
  - (b) an irradiation step comprising exposing said pre-irradiation mixture to actinic radiation while maintaining the temperature of said mixture at a temperature such that spontaneous polymerization is not induced and an activated prepolymer mixture is produced, said activated prepolymer mixture having a viscosity that is functionally unchanged from the viscosity of said pre-irradiation mixture;
  - (c) an assembly step comprising bringing together into common contact a first substrate, a second substrate and said activated prepolymer mixture; and
  - (d) a thermal step comprising applying to said activated prepolymer mixture sufficient heat from an external source to initiate polymerization, whereby said activated prepolymer mixture polymerizes and said two substrates are bonded.

9. A process according to claim 8 additionally comprising an application step interposed between said mixing step and said irradiation step, wherein said pre-irradiation mixture is applied to said first substrate.

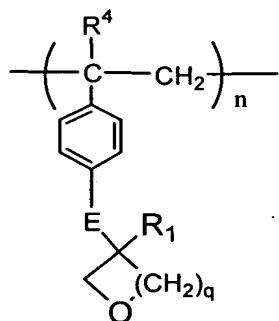
10. A process according to any of claims 1 to 9 wherein said monomer/oligomer component is chosen from oxetane monomers, oxirane monomers of formula:



oxetane oligomers of formula:



oxetane and oxirane oligomers of formula:

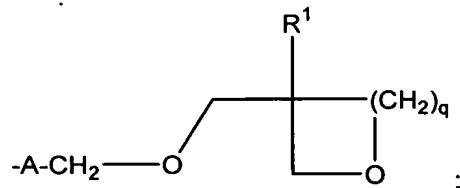


and mixtures of said oxetane and oxirane monomers and oligomers, wherein

R¹ is hydrogen, oxaalkyl or C<sub>1</sub> to C<sub>20</sub> hydrocarbon;

R² is chosen from phenyl, perfluoroalkyl and -CH<sub>2</sub>-R³;

R³ is chosen from C<sub>2</sub> to C<sub>20</sub> hydrocarbon, oxaalkyl, heteroaryl, C<sub>2</sub> to C<sub>20</sub> alkylsiloxane and



$R^4$  is hydrogen or methyl;

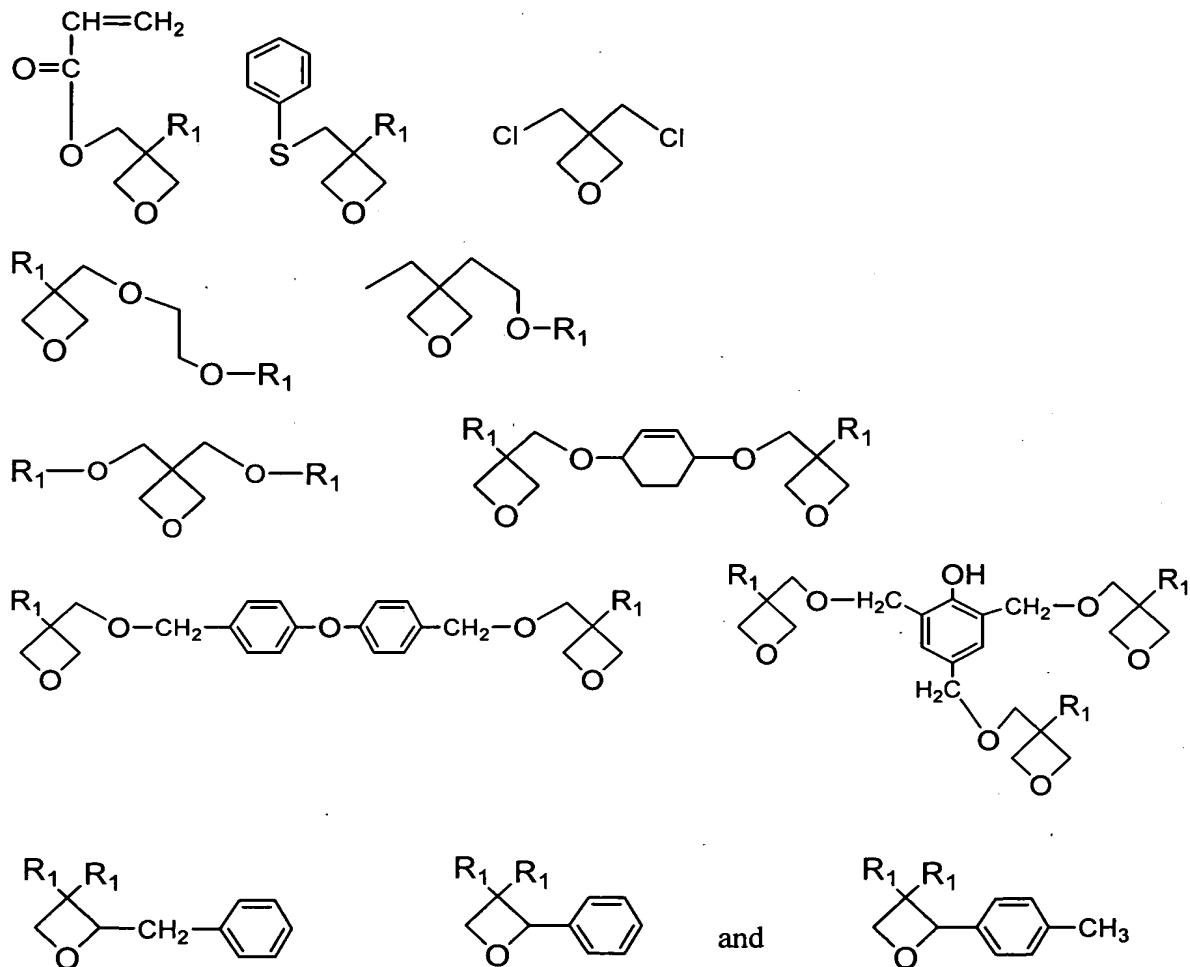
A is chosen from C<sub>2</sub> to C<sub>20</sub> hydrocarbon, oxaalkyl and C<sub>2</sub> to C<sub>20</sub> alkylsiloxane;

E is -CH<sub>2</sub>-O-, -O-CH<sub>2</sub>- or CH<sub>2</sub>-O-CH<sub>2</sub>-;

q is zero or one; and

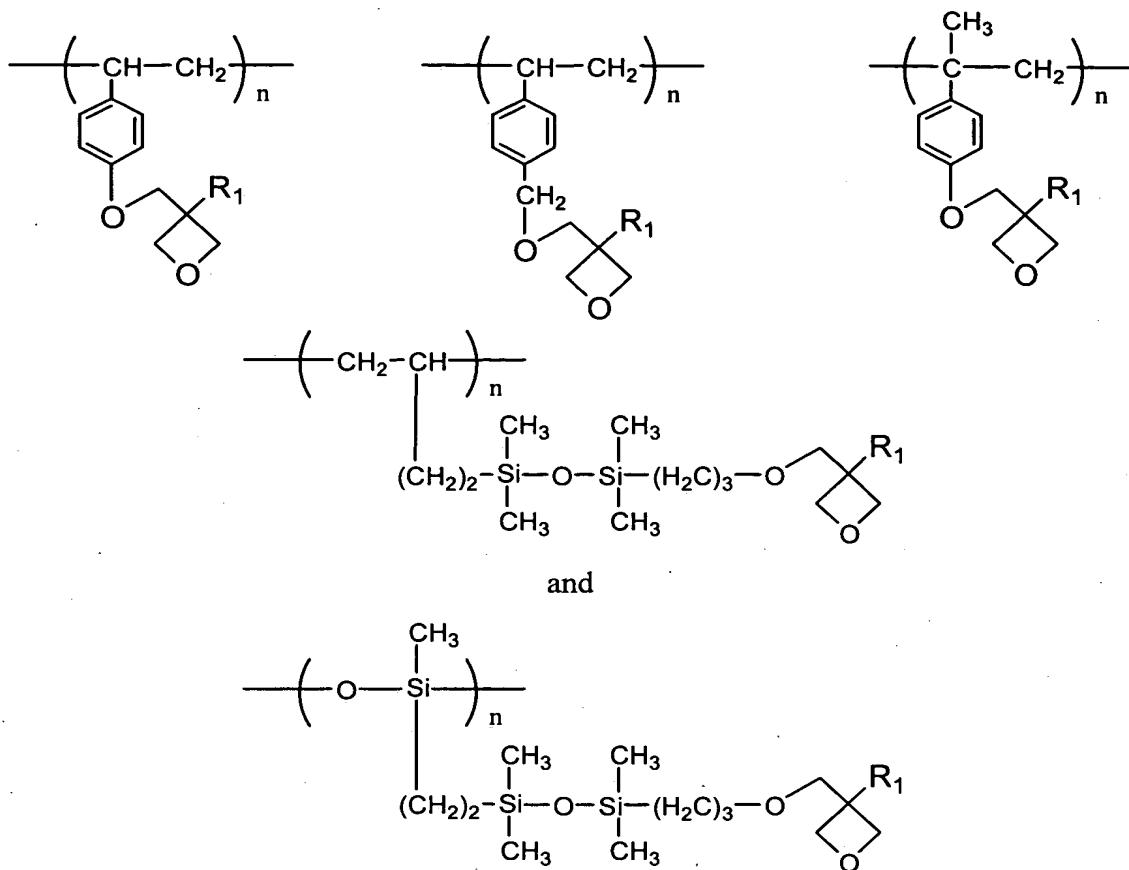
n is a number such that the viscosity of the oligomer is less than 500,000 centipoises.

11. A process according to claim 10 wherein said monomer/oligomer component comprises an oxetane chosen from



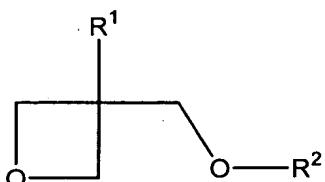
wherein R<sup>1</sup> is hydrogen, oxaalkyl or C<sub>1</sub> to C<sub>20</sub> hydrocarbon.

12. A process according to claim 10 wherein said monomer/oligomer component comprises an oxetane oligomer chosen from



wherein R<sup>1</sup> is hydrogen, oxaalkyl or C<sub>1</sub> to C<sub>20</sub> hydrocarbon; and  
n is an integer from 5 to 100.

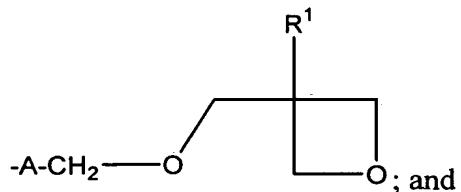
13. A process according to claim 10 wherein said monomer/oligomer component comprises an oxetane of formula



wherein R<sup>1</sup> is oxaalkyl or C<sub>1</sub> to C<sub>20</sub> hydrocarbon;

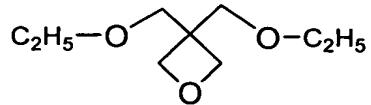
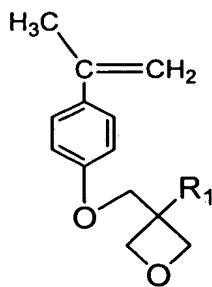
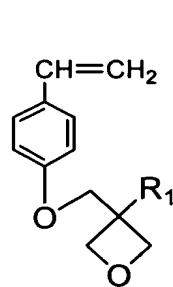
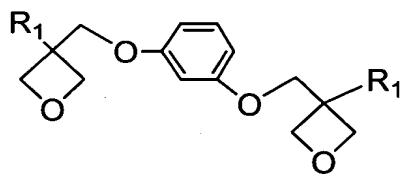
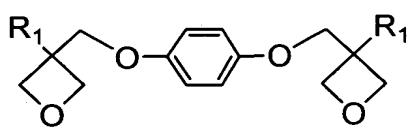
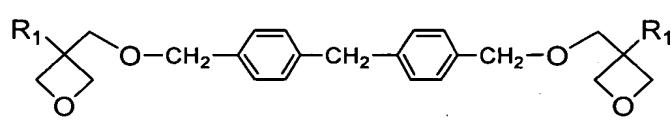
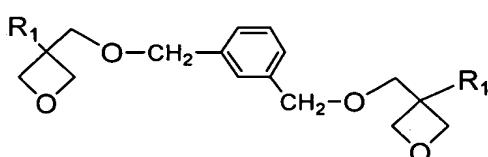
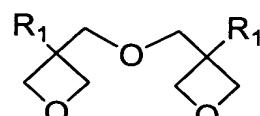
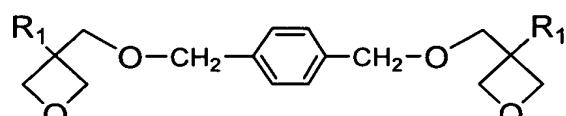
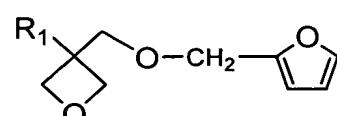
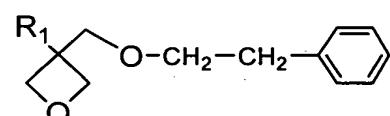
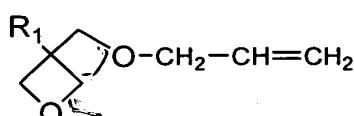
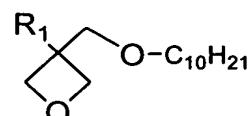
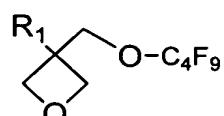
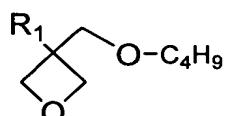
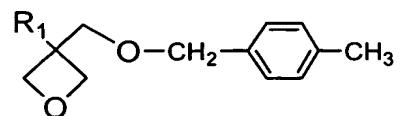
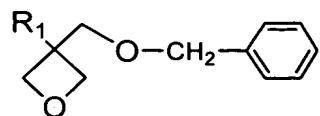
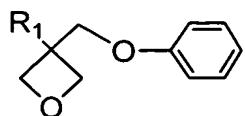
R<sup>2</sup> is chosen from phenyl, perfluoroalkyl and -CH<sub>2</sub>-R<sup>3</sup>;

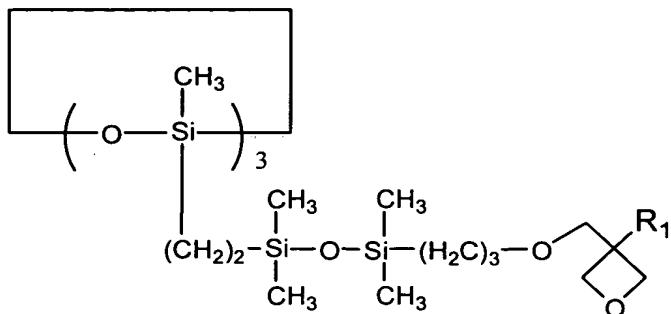
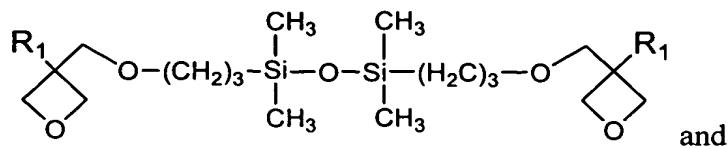
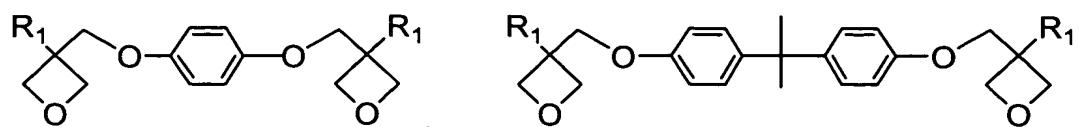
R<sup>3</sup> is chosen from C<sub>2</sub> to C<sub>20</sub> hydrocarbon, heteroaryl, oxaalkyl, C<sub>2</sub> to C<sub>20</sub> alkylsiloxane and



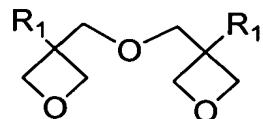
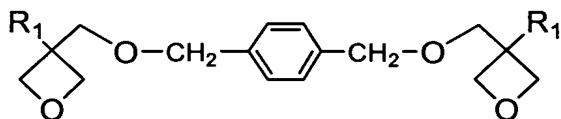
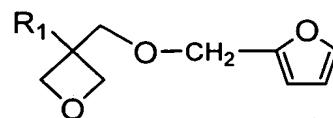
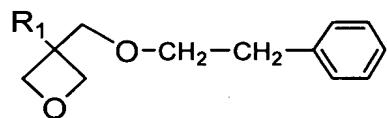
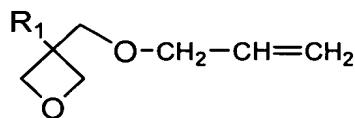
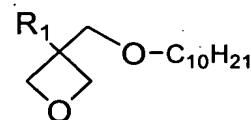
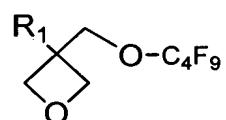
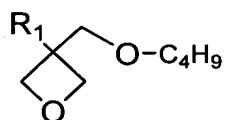
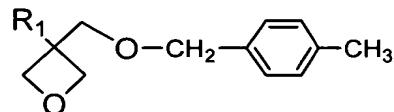
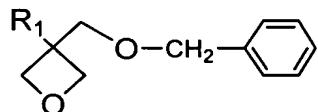
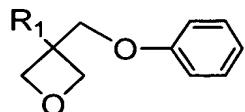
A is chosen from C<sub>2</sub> to C<sub>20</sub> hydrocarbon, oxaalkyl and C<sub>2</sub> to C<sub>20</sub> alkylsiloxane;.

14. A process according to claim 13 wherein said oxetane is chosen from the group consisting of:



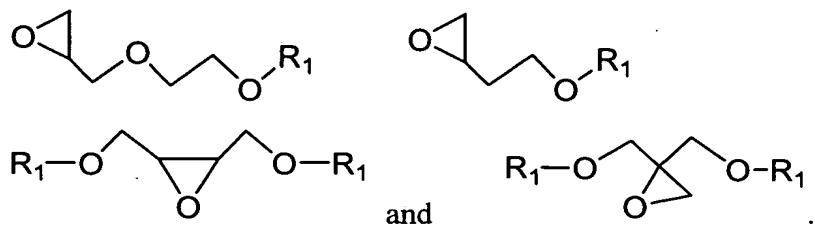


15. A process according to claim 14 wherein said oxetane is chosen from the group consisting of:



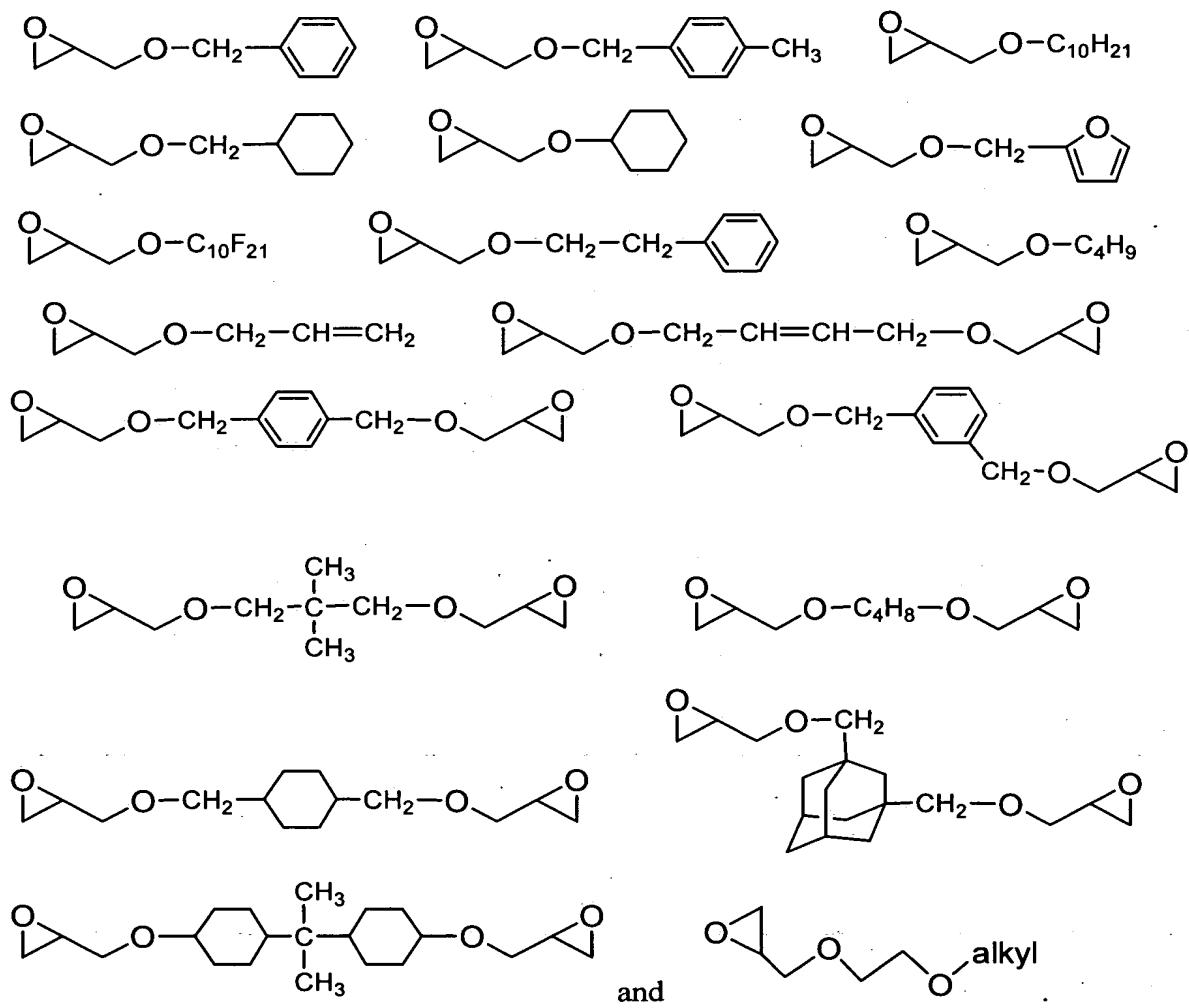
wherein R<sup>1</sup> is loweralkyl.

16. A process according to any of claims 1 to 9 wherein said oxirane is chosen from



17. A process according to claim 10 wherein said oxetane or oxirane is an oxirane and R<sup>1</sup> is hydrogen.

18. A process according to claim 17 wherein said oxirane is chosen from the group consisting of:



19. A process according to claim 8 or 9 wherein both said substrates are fibers.

20. A process according to claim 8 or 9 wherein at least one of said substrates is a rigid surface.
21. A process according to claim 8 or 9 wherein at least one of said substrates is chosen from a rigid metal surface, a rigid glass surface, a rigid polymer surface, a rigid composite surface, a flexible metal surface, a flexible glass surface, a flexible polymer surface and a flexible composite surface.
22. A process according to claim 8 or 9 wherein said irradiation step (b) is separated from said thermal step (d) by a period of greater than two minutes.
23. A process according to claim 22 wherein said irradiation step (b) is separated from said thermal step (d) by a period of greater than five minutes.
24. A process according to claim 22 wherein said irradiation step (b) is separated from said thermal step (d) by a period of greater than ten minutes.
25. A process according to claim 8 or 9 wherein said irradiation step (b) is carried out below ambient temperature and said thermal step (d) is carried by applying an external source of heat above 40°C.
26. A kit for applying and curing a reactive adhesive comprising:
  - (a) a pre-irradiation mixture having a viscosity less than 500,000 centipoises which comprises
    - (i) a catalyst component comprising from 2 to 50 parts by weight of a cationic photoinitiator chosen from the group consisting of triaryl sulfonium, diaryl iodonium, dialkylphenacylsulfonium and hydroxyphenyl dialkylsulfonium salts having counterions chosen from the group consisting of  $\text{SbF}_6^-$ ,  $[(\text{C}_6\text{F}_5)_4\text{B}]^-$ ,  $\text{AsF}_6^-$ ,  $\text{PF}_6^-$ ,  $\text{C}_4\text{F}_9\text{SO}_3^-$ ,  $\text{FSO}_3^-$ ,  $\text{GaF}_6^-$ ,  $(\text{CF}_3\text{SO}_2)_2\text{CH}^-$ ,  $(\text{CF}_3\text{SO}_2)_3\text{C}^-$ ,  $\text{BF}_4^-$  and  $\text{CF}_3\text{SO}_3^-$ ;
    - and
    - (ii) a monomer/oligomer component comprising 1000 parts by weight of one or more of a monomer or oligomer chosen from oxetane monomers,

oxirane monomers, oxetane oligomers and oxirane oligomers, said oxirane monomers and oligomers having at least one oxygen or sulfur of an ether or thioether in a position two or three carbons removed from the oxygen of the oxirane; and

- (b) instructions for separately activating and curing said pre-irradiation mixture.